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Children's Law Center Site Redevelopment

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SODA CITY
ENGINEERING & CONSULTING

University of South Carolina
Civil and Environmental Engineering
Senior Design

Children's Law Center

Engineering Report for Proposed Redevelopment

Columbia, SC
May 2017

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Section 1: Introduction

1.1 Project Description

Soda City Engineering and Consulting was contracted by the USC School of Law to redevelop the Children's Law Center site in Columbia, SC. Currently, the site does not comply with current standards and specifications. The objective of this project is to completely redevelop the site with a new annex building and ensuring everything is up to code, while still allowing the historic structure to maintain its use throughout construction. The project site, as seen in Figure 1.1, is a 1.16 acre lot at the corner of Gervais Street and Pickens Street.

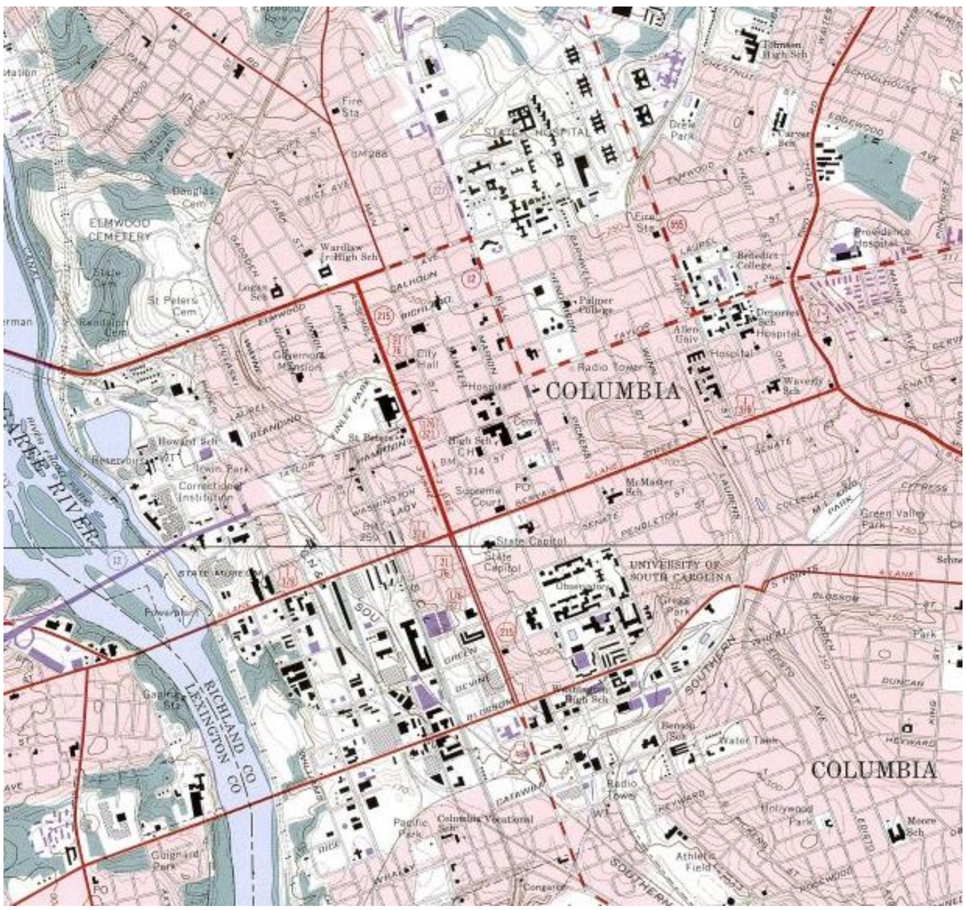


Figure 1.1. Vicinity map of the site.

This report includes details on general site information and existing conditions, the demolition of existing components of the site, clarification on the permits required for this project, a site plan, grading plan, drainage plan, water and sewer plan, SWPP plans, and a cost estimate. A collection of appendices is provided that include all design calculations and important documents.

1.2 Background Information

The Children's Law Center was founded in 1995 by the USC School of Law. The program is in place in order to promote research, training, education and policy development for children's issues. Each year, the center performs over 300 workshops, training programs, and meetings to over 10,000 professionals and volunteers, but the program is critiqued for not having any classrooms, offices, meeting rooms or on-site training facilities. The historic building known as the Whaley House (as seen in Figure 1.2), formerly the Dunbar Funeral Home, was constructed in 1892. Its annex building was the accompanying crematorium. That whole site has been donated to the program to serve as the Children's Law Center offices, classrooms, workshops, meeting rooms, and other necessary spaces for the program to succeed. USC, in partnership with the Historic Columbia Foundation, will restore the Whaley House, while Soda City Engineering & Consulting will create a master plan to complete the rest of the site. The proposed project will create a prominent hub for skilled professionals and volunteers to research, train, and communicate with each other and the public about child protection and advocacy.

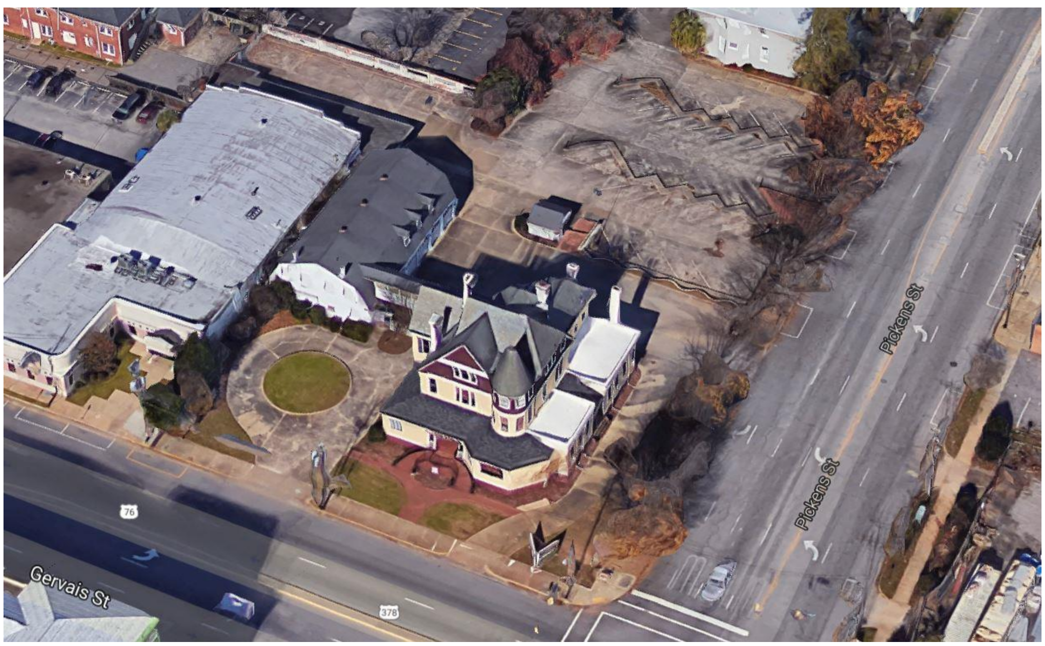


Figure 1.2. Google Earth view of the site on the intersection of Gervais and Pickens.

The intersection surrounding the parcel has a high density of traffic, showing a daily traffic count of about 27,000 between stations 106 and 108 on Gervais street and 4,400 on Pickens street at station 341 (SCDOT). Classified to zone C-4, the City requires certain aspects to be considered for construction of a new building. These requirements include preventing hinderance to the central business district and being sufficient during operation with high volume traffic. Furthermore, aesthetic requirements can include positioning of building/structures on site, appearance of building, and sizing of building. Although being in a historic district and nearby to the central business district has imposed certain considerations on the design, the location provides the engineers with many positive outputs into the design.

1.3 Scope of Work

In summary, the scope of this project includes the following:

- Site Demolition Plan
- Staging Plan
- Site Plan
- Foundation Design
- Pavement Design
- Grading and Drainage Plan and Profile
- Water and Sewer Plan and Profile
- Sediment and Erosion Control Plan
- Cost Estimate

Section 2: Existing Conditions and Demolition Plan

2.1 Existing Site and Demolition

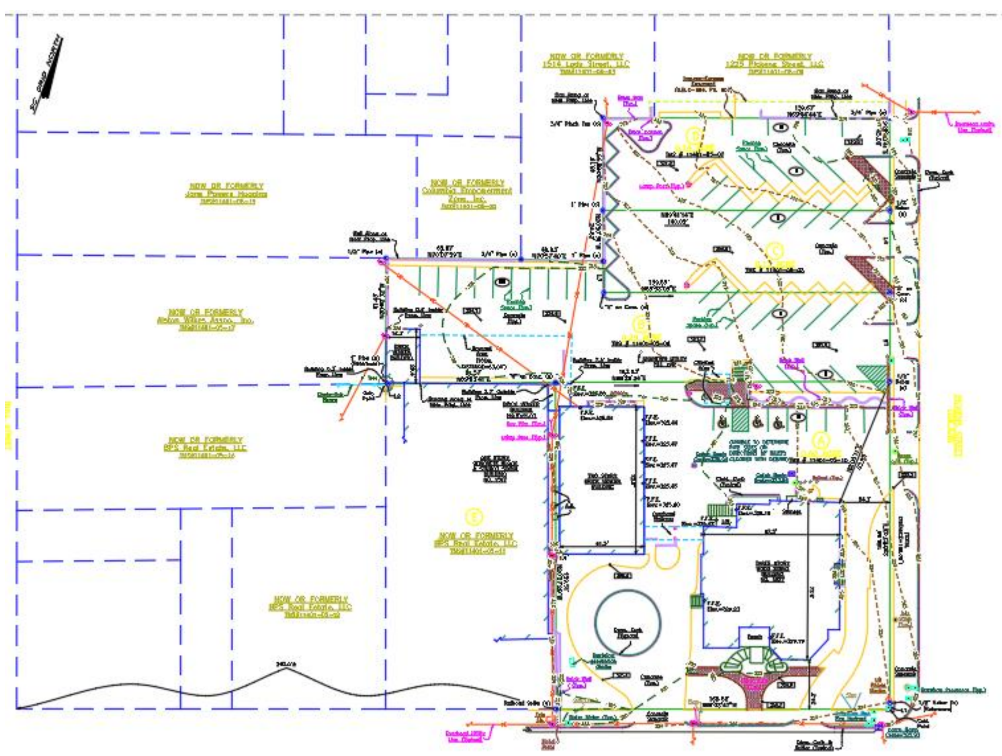


Figure 2.1. Survey of Existing Conditions Provided by Cox and Dinkins, Inc.

The current site layout includes three structures: the Whaley House, the annex house, and its carriage house. It is a historical building and the main area of congregation for prospective users of the site. The Whaley House is to be preserved and protected during the construction stages of the project. The annex building is a two story structure located on the west side of the site. It is attached to the Whaley House by an elevated walkway. This building is deteriorating and will be demolished along with its carriage house.

The parking lot on the site is in very poor condition. Although it does meet ADA requirements for the number of accessible parking spots and signage, the widths of the spaces and travel lanes do not meet standards. All off-street parking for this site will be demolished. Although both the Gervais Street and Pickens Street entrances will remain in the existing locations, driveway widths and curb radii have been altered, so some existing curb will have to be demolished.

Although there are water, sewer, electrical, and gas lines on the site, there is no recorded survey information for their location. According to the survey file provided by Cox and Dinkins, Inc., pipe information for the existing catch basins were not able to be determined due to severe clogging from debris. Because of this, the existing catch basins will be abandoned and invert information for all utility tie-ins are assumed to be four to five feet below existing grade. This will be further explained in Sections 5 and 6.

2.2 Geotechnical Information

Boring logs were provided by Terracon Consultants, Inc. and can be found in the Appendix.

2.3 Staging Plan

Prior to and during construction there will be several staging steps in order to ensure a safe and efficient construction process. The staging will include parking to be decided by the contractor, a storage unit being place on the site, a fence on the perimeter of the construction area with temporary construction entrances, orange construction fence around the Children's Law Center building, and appropriate signage to be placed on Gervais and Pickens street. Also, there will be an office inside of the Children's Law Center building that can be used by the project manager if desired. If the project manager decides to use this room (102) then they must lay down plastic stripping along the walkway to the room as well as in the entire room. After construction begins, a gravel driveway shall be used in order to reduce soil transport into the road from tires.

Section 3: Zoning, Permitting, and Codes

3.1 Zoning

Classified to zone C-4, the City has certain regulations to be considered for the construction of a new commercial building. These requirements include preventing any hindrances to the central business district and being sufficient during operation with high volume traffic. Furthermore, the aesthetic requirements can include positioning of building/structures on site, appearance of building, and sizing of building. The site sits at an elevation between 318’-326’ and is not located in a wetland or floodplain.

3.2 Permitting

Several permits are required to finalize a design for this project. Permits that Soda City Engineering and Consulting will obtain include the following:
- NOI $300 (one-time flat fee)
- Encroachment
- Water and Sewer Service

**All permits and applications fees will be requested by Soda City Engineering and Consulting from client prior to submission.

Along with required permitting, constraints on the site require the proposed design to be reviewed and accepted by the Design and Development Review Commission (DDRC). Application will be completed along with required plan package, and fee ($75.00+$3.00). A meeting with the adjacent properties and neighboring residents has been proposed and concluded for public information and input on the project.

Due to lack of space for the regulatory amount of parking spots, an application for variance is required to send into the Board of Zoning Appeals (BOZA). The application will be submitted to BOZA with requested plans and fee ($125.00).

For more information on DDRC and BOZA please contact:

> **Johnathan E. Chambers**
> Land Development Administrator
> Planning and Development Services
> 1136 Washington Street - Second Floor
> P.O. Box 147
> Columbia, SC 29217
> Office (803) 545-3206
> Fax (803) 733-8699
> Email: jechambers@columbiasc.net

3.3 Code Regulations

The building has two floors each with a square footage of 6,280 ft^2. For coding purposes the CLC building is assumed to have the same square footage of the annex building.
Total Square Footage on Property = 24,960 ft^2
Under the International Building Code section 602.2, the proposed building is type I-B.

The International Fire Code

> Under *table B105.1* in the International Fire Code (IFC), for a type I-B structure the Fire Flow requirement is 1750 gallons per minute with a flow duration of 2 hours for the present square footage.

Under *Table C102.1* in the IFC, any fire-flow requirement 1750 gallons per minute or less requires 1 fire hydrant with an average spacing of 500 feet between hydrants and 250 feet maximum distance from any point on the street or road frontage to a hydrant.

Existing hydrant number and location are acceptable to current standards.

ADA Standards for Accessible Design

Accessible parking spots are in accordance with ADA 2010 Section 502.

Passenger loading zones are in accordance with ADA 2010 Section 503.

Ramps are in accordance with ADA 2010 Section 405.

Section 4: Site Plan

4.1 Site Layout

The proposed site layout has been designed to fit a new 6,373 SF building while still maximizing the amount of parking. While the historic building maintains its current location, the proposed building will be relocated to the northeast corner of the site. The back of the building will face Pickens Street in order to make the parking lot more discreet, thereby aesthetically enhancing Pickens Street. This also provides somewhat of a safety measure as both children and adults will have path to the entrance of the building directly from their vehicles away from the roadside. To make it easier for people to move from one building to the other without vehicle obstruction, an 18’-wide raised crosswalk will be placed in the drive aisle between the buildings.

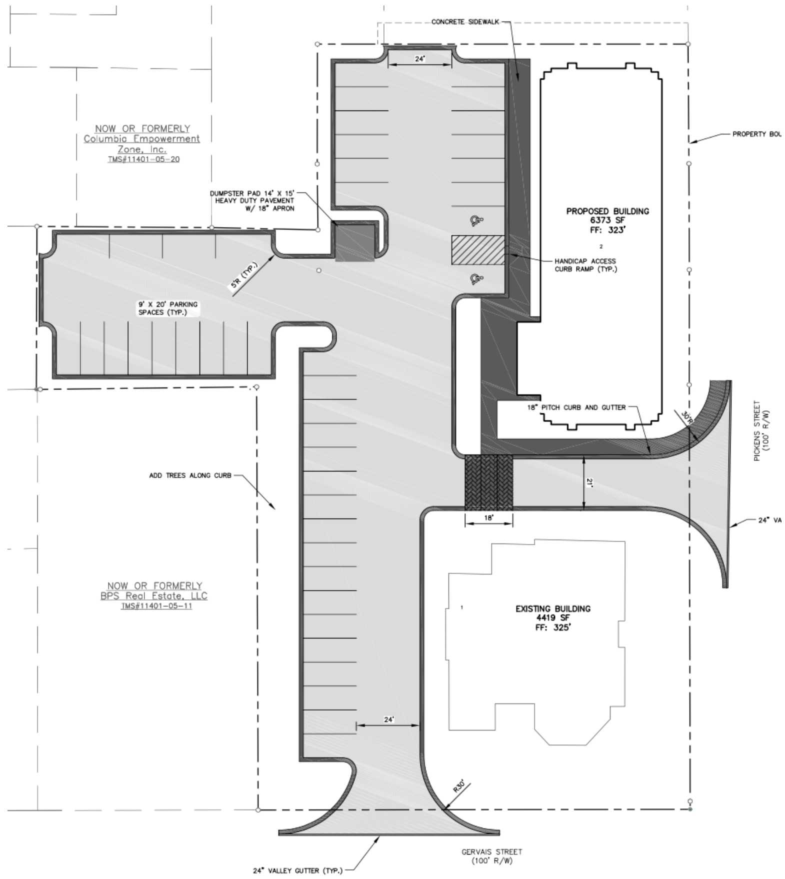


Figure 4.1. Proposed Site Layout

4.2 Parking Lot and Drive Aisles

With 43 general parking spaces and 2 handicap accessible spaces, the lot has been designed for maximum capacity. All parking spaces and access pathways are in accordance with ADA Standards Section 502. A letter of variance shall be sent to BOZA for the number of spaces in this design. Spaces have been omitted in front of the main entrance to the annex building for accessibility. Spaces have been omitted on the west side of the northernmost section of the parking lot in order to fit a 14’ x 15’ dumpster pad on site.

Both the Gervais Street and Pickens Street entrances remain in the existing locations, but driveway widths and curb radii have been altered. The Pickens Street entrance has been converted into a one-way outlet. This is to ensure safety for pedestrians using the aforementioned crosswalk and to allow efficient traffic flow inside the parking area.

4.3 Pavement Design

Flexible Pavement

For this site, the old asphaltic surface will be removed and the parking lot will be repaved using a flexible pavement with a design life of 15 years. The pad that the dumpster will sit on will be a rigid pavement with a design life of 20 years. The flexible pavement was designed using a structural number of 3. For the rigid pavement, 3.5 was used. The thicknesses were adjusted accordingly using SCDOT standard pavement thicknesses for a commercial building.

There are two equations that drive the calculations for the pavement design. Since its flexible pavement for the parking lot, that equation was used to calculate a structural number. This is an AASHTO base standard equation for flexible and two key components are the California Bearing Ratio (CBR) and the soil support value (SSV). The first step was taking a look at the boring logs for site to see what kind of soil was on site. From the logs it was determined consistently around the site that most of the soil was clayey-sand (SC) and silty-sand (SM). These are good soils for pavement so no change or imported soil was needed. From the SCDOT guidelines for pavement, the CBR and soil support value for these types of soils were determined to 8 and 3.2, respectively. With those values, the calculation of the design W_{18} was needed and that can be found using a design life equation:

$$\text{Design life} = \frac{\text{Design } W_{18}}{\text{Daily } W_{18}*365*PDL}$$

For flexible pavement, the max design life that can be used is 15 years and for this project that was used. The daily W_{18} was determined under the assumption that each parking space would be filled three times a day and the dumpster truck will come twice a week. The PDL or proportion of directional W_{18} in the design lane was assumed to be 1.0 because there is only one entrance and one exit for vehicles. So using the daily W_{18} and the design life of 15 years, a design W_{18} was determined to be around 600 ESALs for the design lane. Using excel spreadsheet and that value along with the flexible pavement equation, the structural number was determined as seen below:

$$\log_{10}(W_{18}) = Z_R S_o + 9.36\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\log_{10} M_R - 8.07$$

Input DATA	
W18 (ESALs)	1082
Zr	0
So	0.5
SN	0.572974
ΔPSI	2.2
Mr (lb/in^2)	12000

From the data, the structural number found is considerably low but this is expected because the site is not expected to receive high volumes of traffic. So taking this into the account the structural number equation was used from the SCDOT guideline for pavement:

$$SN = a_1D_1 + a_2D_2M_1 + a_3D_3M_2$$

The a's in the equation represent coefficients that describe the surface, base and subbase of the pavement being laid. The D's in the equation represent the thicknesses of each layer and the M's are the moisture coefficients for the soil. For this site case, the moisture coefficients are considered 1.0 based on the SCDOT guideline on flexible pavement. From here, the DOT thicknesses were used and the goal was to calculate something higher than the value above of SN. The thicknesses for each layer were as followed; 2 ½ in wearing surface, 6 in base, and 6in subbase. The "a" coefficient values were as follows; $a_1 = .44$ for hot mixed asphalt, $a_2 = .12$ for a sand clay base, $a_3 = .10$ for soil based aggregate. So the looks like this:

$$SN = (.44)(2.5)+(.12)(6)(1.0)+(.10)(6) =2.78$$

This value exceeds the value in the table, so the assumption for the pavement was structural number of 3. This was the light duty design for the parking spaces but the thicknesses for the travel lanes were adjusted because of the dumpster truck and other vehicles coming in and out. For the heavy duty pavement the thicknesses were as follows; 3 ½ in wearing surface, 6in for the base, and 6 in subbase. The "a" coefficients remain the same as well as the moisture coefficients. So that structural number was determined as well:

$$SN = (.44)(3.5) +(.12)(6)(1.0) + (.10)(6)(1.0) = 2.86$$

This value is just a little higher than light duty pavement but both are adequate thicknesses based on the standard thicknesses for commercial building parking lots which is found in City of Columbia pavement design manual.

Rigid Pavement Design

For the dumpster pad that is on the site, a rigid pavement design was chosen to accommodate an eight cubic yard dumpster and withstand a 33 kip axle load from the front wheels of the garbage truck. The dumpster pad will have an extended apron for the front wheels to rest upon when extracting garbage so that it doesn't put that weight on the flexible pavement. So for this pavement design, the design life is 20 years and using the same equation from the flexible pavement, a design W_{18} needed to be calculated. Using the AASHTO Esals table for rigid pavement, the equivalent 18- kip Esal value for 33 kip single axle load was found to be 1.0152. The truck is assumed to come twice a week which equates to 104 days out of the year. So the calculation looks for the design lane W_{18}:

$$\text{Design } W_{18} = (20 \text{ years})(1.0152 \text{ Esals/yr})(104 \text{ days}) = 2111.6 \text{ Esals per day truck pickup}$$

With that value calculated, the AASHTO rigid pavement design equation was used to determine the slab thickness based on that design value. The Equation:

$$\log_{10}(W_{18}) = Z_R \times S_o + 7.35 \times \log_{10}(D+1) - 0.06 + \frac{\log_{10}\left(\frac{\Delta PSI}{4.5-1.5}\right)}{1 + \frac{1.624 \times 10^7}{(D+1)^{8.46}}} + (4.22 - 0.32 p_t) \times \log_{10}\left[\frac{(S'_c)(C_d)(D^{0.75} - 1.132)}{215.63(J)\left(D^{0.75} - \frac{18.42}{\left(E_c/k\right)^{0.25}}\right)}\right]$$

This is a long equation with a lot of variables that can be found in the AASHTO standard value tables, and the variable that needs to be calculated is slab thickness. From the excel spreadsheet the values for the coefficient can be seen as well as the thickness recommendation based on these values:

Input Data				
D (in)	0.937208		TSI	2
Ec (lb/in^2)	5000000			
S'c (lb/in^2)	1200			
J	2.7			
ΔPSI	2.5			
So	0.5			
k (lb/in^2)	200			
Zr	0			
Cd	1			
SN4	4			
W18 (Esals)	2111.6			

As seen from the graph the thickness for the slab is recommended to be 1 inch, but this is inadequate because the minimum required slab thickness is 5 inches. For this dumpster pad a slab thicknesses of a thickness of 6 inches was used for the surface and it is unreinforced hot sand mix asphaltic concrete. A reference structural number was also calculated for the rigid pavement with thicknesses of 6in wearing surface, 6in sand clay base, and 6in subbase of soil base aggregate. The equation is as follows:

$$SN = (.35)(6) + (.12)(6.0)(1.0) + (.10)(6.0)(1.0) = 3.42$$

Note that the only change in the equation is to the first coefficient for the wearing surface which is now .35. This is the value for sand mix asphaltic concrete, however if hot mix asphalt concrete is used the structural number is equal to 3.072, so small difference. All values for variables are can be seen in the appendix for pavement design as most of them are from SCDOT guidelines and AASHTO standards.

4.4 Foundation Design

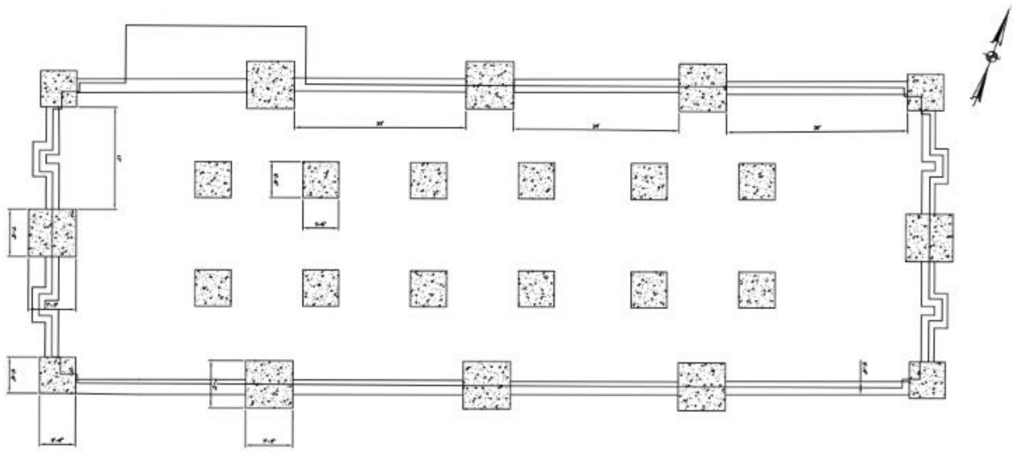


Figure 4.4.1. Plan View of Foundation Elements

Soda City proposes to use a shallow concrete foundation at a burial depth of one foot. Composed of a continuous strip footing that stretches the perimeter of the structure and column footings placed intermediately among strips, the foundation is designed to support an overall load of approximately 1200 tons. To remain within the allowable settlement of less than one inch, the contractor shall construct a site capable of 3000 psf bearing capacity.

Soda City will only provide detail drawings for the footings of the proposed building. The steel reinforcement specifications and overall structural design will be allocated to a structural engineering firm. An example of the calculations used to determine soil properties, bearing capacities, and settlements is provided in Appendix 11.1.

The primary subsurface material that will be supporting the building is a fine to medium sand with clay, formally classified as clayey-sand (SP-SC). Soil properties were estimated through an analysis of the boring data presented in Log B-3. Due to the relatively low blow counts presented in the standard penetration boring log, settlement criteria was the driving factor in this design.

Columns and strips were sized based on their assumed loading demands. Loads may vary depending on architectural preferences, so it should be noted that member sizes are tentative. Bearing capacities for foundation members were estimated using Terzaghi's General Bearing Capacity Equation. Corrections were made for the shape and depth of foundation members, as well as the compressibility of the soil layer. This design was conducted in conformance with Section 1805 of the International Building Code and the American Concrete Institute's foundation specifications. The ACI designates a minimum 28-day compressive strength of 2500 psi for all concrete used in foundation members.

Overall foundation settlement was estimated based on the Theory of Elasticity. To meet settlement criteria the site shall be compacted from a very loose condition to the densest condition possible. Surface compaction will likely be achieved with the use of a vibratory smooth drum roller. Some subsurface compaction may be necessary to prevent deep settlement and would be achieved through vibroflotation methods. The on site soil's modulus of elasticity is estimated to be 40,000 psf, this is the main factor in estimating settlement. In order to meet the allowable criteria of less than one inch settlement, the site shall be compacted to a modulus of elasticity equal to 240,000 psf.

Pending a site specific study, the Children's Law Center will be classified in Seismic Site Class D. This designates an ordinary occupancy structure in a zone susceptible to seismic forces. The structure shall be designed to resist seismic forces, all non-structural components shall be secured, and special construction details shall be provided.

Section 5: Grading and Drainage Plan

5.1 Grading Design

The main goal of the grading and drainage design is keeping stormwater on site and reducing the potential for excess runoff in the right-of-ways. The topography of the site requires a significant change to grading in order to provide correct drainage and enough cover for utilities. The major challenge that comes into play is tying in a proposed grade to a less than ideal existing grade on all four sides of the parcel and around the Whaley House. The design began with a proposed finished floor elevation for the new annex building. By working backwards from there, low point elevations were able to be determined for optimal drainage.

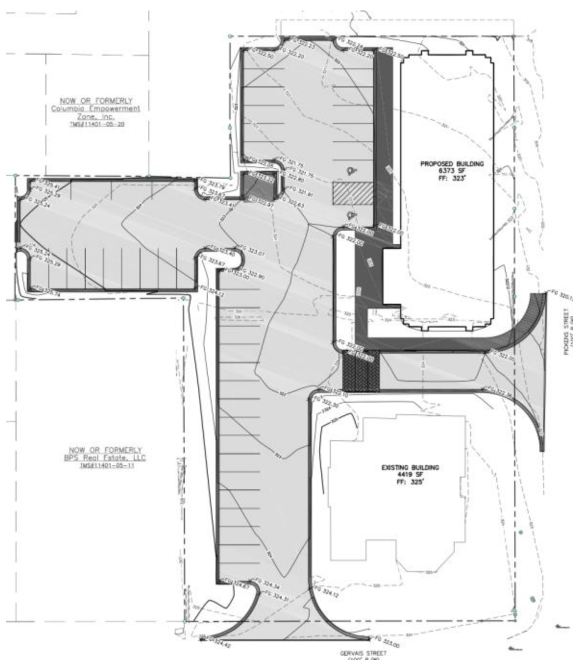


Figure 5.1.1. Grading Plan with 1' Contours

5.2 Drainage Design

The existing stormwater drainage system on the site has not been able to be examined fully through survey or excavation because it is full of debris and soil. Only two grate inlets, placed relatively close to each other, are currently located on site a few feet north of the back of the existing three story house. Currently, the bottom third of the site drains to the grate curb inlet near the north western corner of the Gervais St. and Pickens St. intersection. The second grate curb inlet, located on the left side of the road just before the Lady St. and Pickens St. intersection, catches the runoff from the site north of the Whaley House. The existing system is not adequate for the proposed plans of the site, therefore, all existing pipes, inlets, junctions, and other stormwater system structures will be abandoned unless they directly impede in the proposed system and/or other site utilities in which case the existing structures will be removed. During the construction phase of the project, the soil on site will be exposed for grading purposes. The soil was unable to be determined from the Web Soils Survey, therefore, a conservative estimate will be used. The assumed disturbed soil will have the characteristics of a soil with a high runoff potential and a hydrologic soil group of C or D. The assumed runoff coefficient used for this soil on mild slopes around two percent is 0.70. Approximately 0.92 acres of the site surface will be this soil during the construction phase. On site sediment and erosion protective measures that will be put into practice are described in section 7. The flow rates for the two street grate curb inlets will be calculated with the methods listed below for the pre-construction, construction, and post-construction phases.

The stormwater drainage plan for the site involves adding two drop grate inlets in the center of the driving aisle of the parking lot and a curb inlet on the exit-only driveway to Pickens Street. The proposed stormwater sewer system will tie into the existing stormwater sewer line on Pickens Street. As stated in the City of Columbia ordinance for storm sewer design (Sec. 6-5004a), the design storm for the site shall be 10 years because the site is under 40 acres in size. The flows expected for the 25, 50, and 100 year return frequency storms also shall be calculated (Paragraph 4.2.4). The runoff flows for each inlet are calculated using the rational method. The City of Columbia ordinance for storm sewer design Sec. 6-5004c states that the flow rates used for the sizing of storm sewer pipes can be found by the rational method because the site is less than 500 acres. The weighted runoff coefficients for the runoff surfaces are found for each inlet along with the drainage area using the post-construction grading plan contours. The runoff coefficients used are from the Richland County storm drainage design standards Table 2, "Recommended Runoff Coefficients," which is listed in the appendix.

The time of concentration values found for each inlet are calculated and compared to a minimum time of concentration of five minutes. Five minutes is a generally accepted minimum time of concentration when calculating rainfall intensity because intensity-duration frequency curves usually do not extend out before five minutes. It is not realistic to use a time of concentration less than five minutes because storms rarely last less than five minutes and a lower time of concentration will create an unlikely rainfall intensity. Also, the initial abstractions of the precipitation from the runoff surfaces prevent storms with a time of concentrations smaller than five minutes from producing any significant runoff. As shown by the calculations in the appendix, a minimum time of concentration of five minutes will control all of the inlet runoff flow calculations. The time of concentrations found for each inlet using the Soil Conservation Survey (SCS) Upland Method are then used to find the rainfall intensity using the IDF curve coefficients for Columbia, SC which are from the South Carolina Department of Transportation and referenced by the Richland County storm drainage design standards.

The preliminary sizing of the pipes in the system is done using the design flow rate found from the rational method, and Manning's equation. The preliminary pipe sizing is done with a spreadsheet created to estimate the pipe characteristics such as velocity, velocity head, and flow depth by using a trial and error method to estimate the theta value in the pipe for a given flow rate, pipe slope, Manning's n value, and an initial assumed pipe diameter. Slope, velocity, velocity head, and depth of cover are needed in order to correctly design the stormwater system. It is generally accepted in the civil engineering practice that minimum pipe slopes shall not be less than 0.50%. The City of Columbia ordinance for storm sewer design paragraph 4.3.2.3 states that "grades will be such as to produce minimum velocities of 2 feet per second. Velocities up to 20 feet per second are acceptable provided adequate blocking is provided and that this velocity is reduced so as to prevent erosion at the outlet end of the structure." Paragraph 4.3.2.5 states that "structures shall have adequate cover to prevent damage from traffic and from other structures." Paragraph 4.3.2.5.1 says the "depth at inlets shall be such that the distance from the water surface above the inlet to the water surface in the pipe will be equal to or exceed the velocity head of water in the pipe." All of these requirements from the City of Columbia are met with this design when calculated with the spreadsheet and when the analysis is done with Hydraflow and AutoCAD Civil 3D.

The system is more accurately sized by using Hydraflow to create a stormwater sewer system based off of the known flow rates from the rational method. The inverts are placed based off of a minimum depth of cover of four feet below grade for the existing stormwater sewer system tie in on Pickens Street. The upstream invert elevation of the existing stormwater sewer pipe on Pickens Street was assumed to be 310.50 feet in order to accommodate other utility requirements. It should be noted that the City of Columbia does not accept drainage pipes less than 18 inches in diameter. The pipe sizing calculations are done with this minimum in mind and this is why only 18 inch reinforced concrete pipes are used for the drainage system because of the small, isolated drainage area. The three pipes within the site are all 18 diameter reinforced concrete pipes with lengths that vary from 50 feet to 117 feet. The following figures show the plan view and profile view of the stormwater sewer system, and the calculated flow rates through each inlet and pipe along with a comparison of the two street curb inlets' pre-construction runoff conditions to their post-construction runoff conditions.

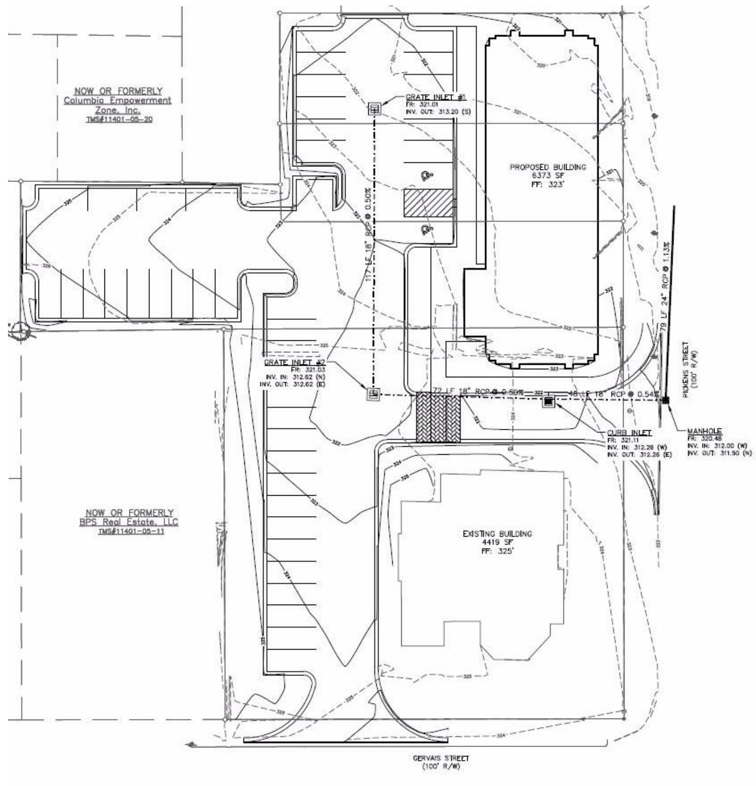


Figure 5.2.2. Stormwater sewer system plan view

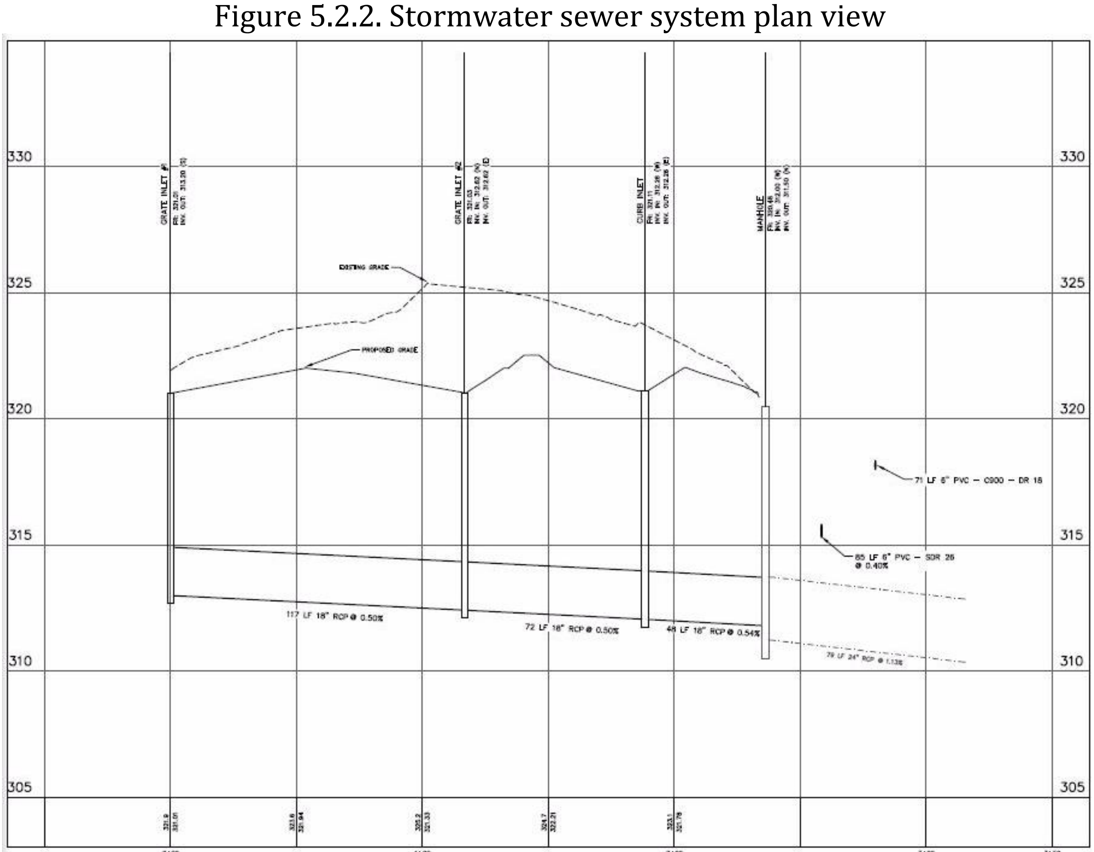


Figure 5.2.3a. Stormwater sewer system profile view

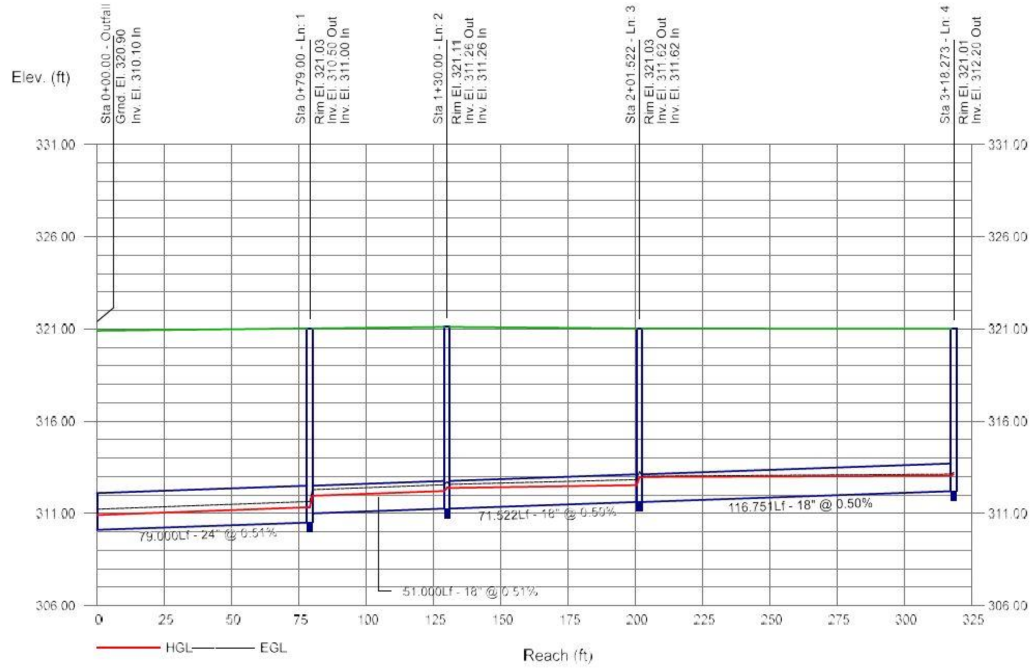


Figure 5.2.3b.. Stormwater sewer system profile view with flow depths

Flow Rate for Inlets and Pipes (cfs)									
Curb Inlet on Gervais Street					Curb Inlet on Pickens Street				
Year Storm	Pre-Construction	Construction	Post-Construction	% Decrease For Pre & Post	Year Storm	Pre-Construction	Construction	Post-Construction	% Decrease For Pre & Post
10	1.32	1.46	0.54	59.19	10	8.93	8.17	4.75	46.85
25	1.66	1.85	0.68	59.19	25	11.28	10.31	5.99	46.85
50	2.01	2.23	0.82	59.19	50	13.60	12.43	7.23	46.85
100	2.29	2.54	0.93	59.19	100	15.51	14.18	8.24	46.85

Grate Inlet 1		Grate Inlet 2	
Year Storm	Post-Construction	Year Storm	Post-Construction
10	2.47	10	2.44
25	3.12	25	3.07
50	3.76	50	3.71
100	4.29	100	4.23

Curb Inlet 1		Pipe 1	
Year Storm	Post-Construction	Year Storm	Post-Construction
10	0.57	10	2.47
25	0.72	25	3.12
50	0.87	50	3.76
100	0.99	100	4.29

Pipe 2		Pipe 3	
Year Storm	Post-Construction	Year Storm	Post-Construction
10	4.90	10	5.47
25	6.19	25	6.91
50	7.47	50	8.34
100	8.52	100	9.51

Figure 5.2.3. Flow Rates for Inlets and Pipes

The site is located in “Zone X” on the FEMA FIRMettes and therefore is not impacted by a flood plain. The maps are shown below.

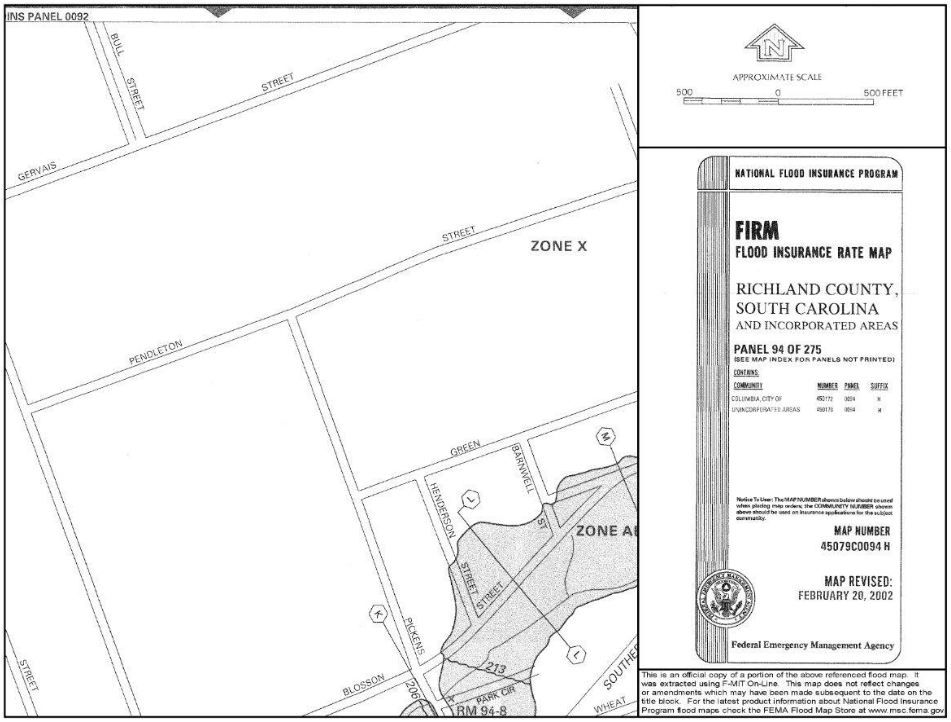


Figure 5.2.4. FEMA Flood Insurance Rate Map

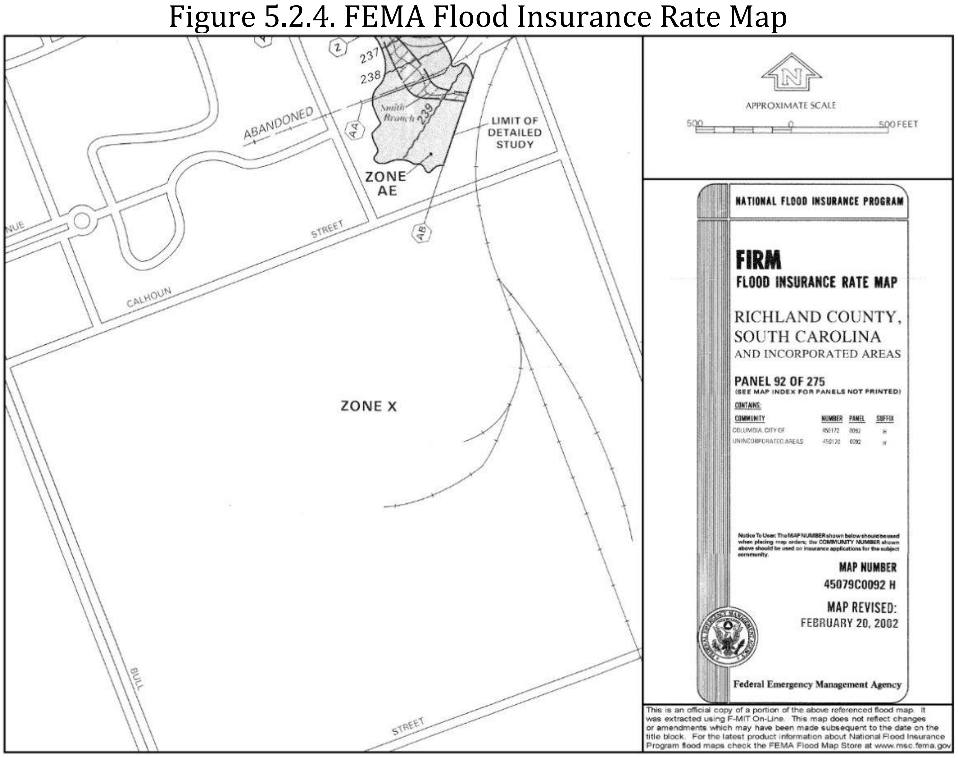


Figure 5.2.5. FEMA Flood Insurance Rate Map

Section 6: Water and Sewer Plan

6.1 Water Design

Existing conditions on the site include a fire hydrant located at the southeast corner of the site, a 6" water main along Pickens St. east of the site, and an 8" water main along Gervais St. south of the site. The locations of these utilities were provided by City of Columbia. Soda City Engineering has provided the water supply design for the proposed training center building; it is assumed that utilities for the existing historic Whaley House building will be left as-is.

The City of Columbia, in accordance with the International Fire Code, stipulates that the maximum spacing between hydrants and the maximum distance of any point of a building from a fire hydrant is 500'. The existing hydrant located at the corner of Pickens and Gervais Streets will suffice for the post-construction conditions of the site as the furthest corner of the building is located at a distance of approximately 330' from the hydrant; therefore no new hydrants are needed.

Soda City Engineering proposes that a 4" pipe constructed of PVC C-900 piping extend perpendicular from the water main along Pickens St. to the proposed training center building, where it will tie into the building. The City of Columbia does not accept water supply pipe sizes smaller than 4"⌀ and requires that pipes between 4" and 8" be constructed of PVC C-900 or ductile iron.

Using the square footage of the proposed training center of 12,480, the maximum occupancy was estimated at 345 persons. In accordance with the International Plumbing Code (IPC), the building requires a minimum of 7 male toilets, 7 female toilets, 6 total lavatories, 3 drinking fountains, and 1 service sink. Using Hunter's method, supported by the IPC, the total fixture units for these elements is 156.5, equivalent to 80.3gpm maximum probable flow. Adding 26 gpm for fire sprinklers and 10 gpm for an outdoor hose bibb for irrigation, the total estimated maximum probable flow is 116.3 gpm, or 0.26 cfs.

The total dynamic head required to service the second floor of the building, at a height of 30' above the finished floor elevation, was calculated at 35.15 psi. A 4" provides adequate flow to meet the determined demand at this height. The City of Columbia provides water service at a pressure between 80-125 psi, eliminating the need for a booster pump to provide service to the top floor of the building. The City of Columbia also requires a mean flow velocity between 2ft/s-8ft/s. The recommended pipe size provides a velocity of 3.05ft/s, within the required design values.

6.2 Sewer Design

Existing sanitary sewer utilities on the site include an 8" sanitary sewer main along Pickens St. east of the site, and an 8" sanitary sewer main along Gervais St. south of the site. The locations of these utilities were provided by City of Columbia. Soda City Engineering has provided the sanitary sewer design for the proposed training center building; it is assumed that utilities for the existing historic Whaley House building will be left as-is.

Soda City Engineering proposes a 6" PVC sanitary sewer pipe extend perpendicular from the main located along Pickens St. to the proposed building and tie into the building. To ensure a mean velocity of at least 2ft/s, as required by the City of Columbia, the pipe should be sloped towards the main on a minimum slope of 0.5ft per 100 ft.

Maximum probable flow was estimated using SCDHEC Standards for Wastewater Facility Construction, which estimates 25 gpd per person in an office setting.

The City of Columbia requires an 8" minimum pipe size for sanitary sewer under normal conditions; however, a 6" minimum pipe size can be used when the flow of the service line is below 10% of the design capacity of the receiving sewer line. The design flow was estimated at 24.24 gpm, determined using a peaking factor of 4.05. Using Manning's Equation, the required slope was determined to be 0.4%; however, 0.5% is required by SCDHEC for 6" pipe. The calculated flow velocity was 3.05ft/s, above the required 2ft/s.

City of Columbia design criteria also stipulates a minimum horizontal separation distance of 10' and vertical separation distance of 18" between water service lines and any sanitary sewer, storm sewer, or contaminated water service line or main. A minimum cover of 36" is required for both water and sewer lines. A backflow preventer device will also be installed on the water service line to prevent contamination of the city's water supply, and a cleanout structure will be installed at the connection of the sewer service line and sewer main.

Additional utilities, including electric and gas, are provided by SCE&G and lie outside the scope of work of Soda City Engineering for this project.

Section 7: Erosion and Sediment Control

Prior to the beginning of an construction the proper Erosion and Sediment Control practices must be emplaced to ensure the conveyance of clean water into inlets. With a land disturbance of 0.92 acres the site will be a singular phase.

7.1 Planned Erosion and Sediment Control Practices

During the construction phase it will be required to install a silt fence that must have 48 inch long steel post painted with water based baked enamel paint with a minimum yield strength of 50,000 psi, with standard "T" sections with a nominal face width of 1.38 inches and a nominal "T" length of 1.48 inches. The steel post must also weigh 1.25 pounds per foot, which will require minimum 17- square inch stabilizing plate. The filter fabric will be a geotextile filter fabric, that will be attached to post spaced a maximum 6 feet apart. The silt filters will catch runoff at the toe end of slopes, while also serving as a boundary for construction. A temporary stabilized construction entrance will be situated at the southwest corner and eastern sides of the property, with the road consisting of 2 to 3 inch D_50 Aggregate with a minimum thickness of 6-inches. For inlet protection it will be a two part process as a Type B Filter Fabric Inlet Protection will be used until the surface is established and laid with the hot mix asphalt. The Type B filter must have steel post the same as the silt fence along with, hardware fabric or comparable wire mesh with max openings of 0.5x0.5 inches as the supporting material, which will be extended 6 inches into the ground with back of soil or crushed stone compacted over the fabric. The steel post will be spaced a maximum of 3-feet apart around perimeter of inlet, and will be driven a minimum of 24-inches into the ground. Heavy duty wire ties spaced 6-inches apart to attach the wire mesh material to steel post. Aggregate No. 5 washed stone will be placed against the hardware fabrics on all sides at a minimum of 12-inches and a maximum of 24-inches. Once the hot asphalt is laid, the type B Filter will be replaced with a catch basin insert and for our site specifically we will be using a Dandy Bag. By the time all the asphalt is laid a curb inlet will have been installed, that will be protected by an F type Drain inlet protection. With the close Proximity to the neighboring properties, Dust Control measures will be enacted to prevent the disturbance of the commercial sites. This will simply be a fine spray of water over the site to maintain a more cohesive topsoil.

7.2 Maintenance Plans

In order to maintain the effectiveness of the BMP's a proper maintenance plan must be enacted. A measure required for all BMP's is the inspection of all devices and practices within a 7 day period and within 24 hours after a runoff producing rainfall event. If an repairs are needed they shall be performed immediately to maintain design integrity. During these inspections if it is noticed that on the silt fence or Filter inlets the sediment has reached a height of ⅓ of the respective mechanism, then the sediment will be removed immediately to prevent clogging. Finally whenever a vehicle leaves through the temporary driveway and tracks mud or sediment onto a public road it will be immediately brushed or swept.

7.3 Construction Schedule

1. Obtain plan approval and all other applicable permits
2. Establish property boundaries and flag work limits
3. Hold pre-construction conference at least one week prior to starting construction
4. Install Temporary Gravel construction entrance/exit as first phase of construction activity
5. Install Type B and F Filter Inlet over existing storm drainage inlets
6. Install silt fence.
7. During the construction process in order to prevent dust from entering neighboring sites water will be sprayed to reduce dust emissions
8. When ASPHALT is laid remove Type B inlet filter and install Dandy Bags in grate inlets.

9. All Erosion and Sediment control practices will be inspected weekly and following all rainfall events

Section 8: Cost Estimate

8.1 Cost Estimate

Item	Units	Quantity	Unit Price	Total Cost ($)
Mobilization		1	30,000	30,000
Bonds and Insurance		1	20,000	20,000
Traffic Control		1	10,000	10,000
				60,000
Demolition				
Remove Commercial Building	SF	3260	3.84	12518.4
Remove Driveways	SY	40	3.4	136
Removal of Surface Materials (Concrete, Curb & Gutter, Subbase)	SY	4645	25	116125
Remove Existing Storm Drainage Piping	LF	240	16	3840
				132619.4
Earthwork				
Subgrade, Fine Grading +/- 1'	CY	2,370	242.34	574345.8
Rough Grade with Dozer (75HP)	CY	2030	0.72	1461.6

				575807.4
Utility Pipelines				
4" PVC C-900	LF	62	2.24	138.88
8" PVC C-900	LF	72	7.69	553.68
Tap fee	ea.	1	3500	3500
Tap Equip	ea.	2	2500	5000
Backflow	ea.	1	360	360
Cleanout	ea.	2	450	900
				10452.56
Site Drainage				
18" RCP CLIII	LF	240	45	10800
4' Diameter Storm Drain Manhole	ea.	1	2550	2550
Single Grate Inlet Catch Basin Box	ea.	2	2725	5450
Curb Drop Inlet	ea.	1	4968.05	4968.05
				23768.05
Paving and Surfacing				
Hot Mix Asphalt - Type A (light pavement)	Ton	126.8	65	8242
Hot Mix Asphalt - Type A (heavy pavement)	Ton	288.25	65	18736.25

Subbase Aggregate	Ton	787.6	20	15752
Sand/Clay base	Ton	798.5	40	31940
				74670.25
Foundation				
2500 PSI Concrete	CY	150	106	15900
				15900
Signage, Paint				
Stop Sign, 24"x 24" With Post Reflectorized, OSHA Standard	ea.	2	96.32	192.64
Exit Sign, 12"x 18" With Post Reflectorized, OSHA Standard	ea.	1	69.24	69.24
Entry Sign, 12"x 18" With Post Reflectorized, OSHA Standard	ea.	1	69.24	69.24
Handcp Pkng Sgn, 12"x 18" With Post Reflectorized, OSHA Standard	ea.	2	60.55	121.1
Traffic directional arrows	ea.	2	150	300
Roadwork Sign	ea.	2	9.41	18.82
Parking Lot Striping	LF	880	0.23	202.4
Do Not Enter Sign	ea.	1	30	30
				1003.44

Sed. Erosion control				
Silt Fence	LF	685	4	2740
Temporary Construction Entrance	ea.	2	4000	8000
Dandy Bags	ea.	2	45	90
Beaver Dam	ea.	3	115	345
Type B Filter Fabric Inlet Protection	Roll	1	43	43
Aggregate #5, Washed Stone	Ton	1	19.5	19.5
				11237.5
Misc.				
Wood Structure for Dumpster/Installation	ea.	1	1400	1400
Dumpster	ea.	1	1000	1000
				2400
Sum				907,859
Contigency				
10%				90785.86
Total				998,644

Appendices

Fire Hydrant Reference Tables

TABLE B105.1
MINIMUM REQUIRED FIRE FLOW AND FLOW DURATION FOR BUILDINGS[a]

FIRE-FLOW CALCULATION AREA (square feet)					FIRE FLOW (gallons per minute)[c]	FLOW DURATION (hours)
Type IA and IB[b]	Type IIA and IIIA[b]	Type IV and V-A[b]	Type IIB and IIIB[b]	Type V-B[b]		
0-22,700	0-12,700	0-8,200	0-5,900	0-3,600	1,500	
22,701-30,200	12,701-17,000	8,201-10,900	5,901-7,900	3,601-4,800	1,750	
30,201-38,700	17,001-21,800	10,901-12,900	7,901-9,800	4,801-6,200	2,000	2
38,701-48,300	21,801-24,200	12,901-17,400	9,801-12,600	6,201-7,700	2,250	
48,301-59,000	24,201-33,200	17,401-21,300	12,601-15,400	7,701-9,400	2,500	
59,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9,401-11,300	2,750	
70,901-83,700	39,701-47,100	25,501-30,100	18,401-21,800	11,301-13,400	3,000	
83,701-97,700	47,101-54,900	30,101-35,200	21,801-25,900	13,401-15,600	3,250	3
97,701-112,700	54,901-63,400	35,201-40,600	25,901-29,300	15,601-18,000	3,500	
112,701-128,700	63,401-72,400	40,601-46,400	29,301-33,500	18,001-20,600	3,750	
128,701-145,900	72,401-82,100	46,401-52,500	33,501-37,900	20,601-23,300	4,000	
145,901-164,200	82,101-92,400	52,501-59,100	37,901-42,700	23,301-26,300	4,250	
164,201-183,400	92,401-103,100	59,101-66,000	42,701-47,700	26,301-29,300	4,500	
183,401-203,700	103,101-114,600	66,001-73,300	47,701-53,000	29,301-32,600	4,750	
203,701-225,200	114,601-126,700	73,301-81,100	53,001-58,600	32,601-36,000	5,000	
225,201-247,700	126,701-139,400	81,101-89,200	58,601-65,400	36,001-39,600	5,250	
247,701-271,200	139,401-152,600	89,201-97,700	65,401-70,600	39,601-43,400	5,500	
271,201-295,900	152,601-166,500	97,701-106,500	70,601-77,000	43,401-47,400	5,750	
295,901-Greater	166,501-Greater	106,501-115,800	77,001-83,700	47,401-51,500	6,000	4
—	—	115,801-125,500	83,701-90,600	51,501-55,700	6,250	
—	—	125,501-135,500	90,601-97,900	55,701-60,200	6,500	
—	—	135,501-145,800	97,901-106,800	60,201-64,800	6,750	
—	—	145,801-156,700	106,801-113,200	64,801-69,600	7,000	
—	—	156,701-167,900	113,201-121,300	69,601-74,600	7,250	
—	—	167,901-179,400	121,301-129,600	74,601-79,800	7,500	
—	—	179,401-191,400	129,601-138,300	79,801-85,100	7,750	
—	—	191,401-Greater	138,301-Greater	85,101-Greater	8,000	

For SI: 1 square foot = 0.0929 m^2, 1 gallon per minute = 3.785 L/m, 1 pound per square inch = 6.895 kPa.

a. The minimum required fire flow shall be permitted to be reduced by 25 percent for Group R.

b. Types of construction are based on the *International Building Code*.

c. Measured at 20 psi.

Table C102.1 REQUIRED NUMBER AND SPACING OF FIRE HYDRANTS

FIRE-FLOW REQUIREMENT (gpm)	MINIMUM NUMBER OF HYDRANTS	AVERAGE SPACING BETWEEN HYDRANTS[a, b, c, f, g] (feet)	MAXIMUM DISTANCE FROM ANY POINT ON STREET OR ROAD FRONTAGE TO A HYDRANT[d, f, g]
1,750 or less	1	500	250
2,000-2,250	2	450	225
2,500	3	450	225
3,000	3	400	225
3,500-4,000	4	350	210
4,500-5,000	5	300	180
5,500	6	300	180
6,000	6	250	150
6,500-7,000	7	250	150
7,500 or more	8 or more[e]	200	120

Boring Logs and Foundation Calculations

JOB #	BORING #	SHEET
38:1429	B-3	1 OF 1

ARCHITECT-ENGINEER

SITE LOCATION: Hampton Street and Williams Street, Columbia, SC

NORTHING | EASTING | STATION

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION 201.5'

–○– CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY: RQD% – – –, REC% ———

PLASTIC LIMIT% — WATER CONTENT% — LIQUID LIMIT%

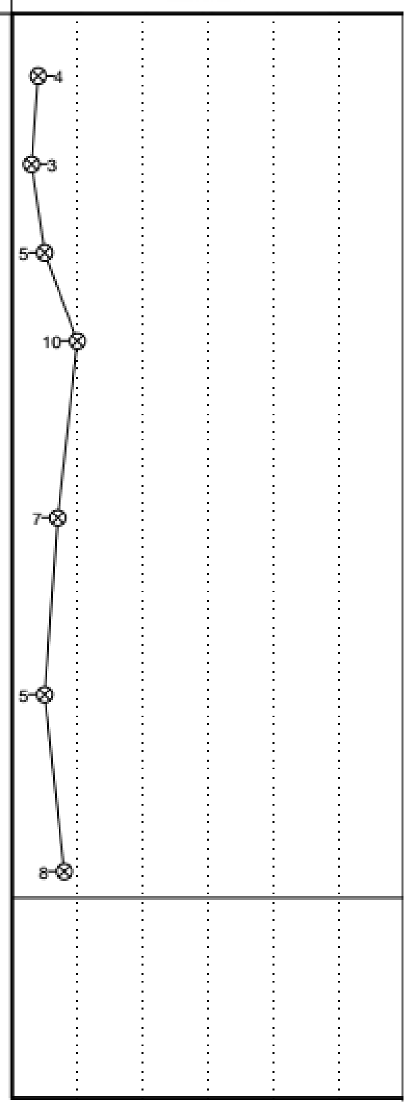
⊗ STANDARD PENETRATION BLOWS/FT

Description of Material
Topsoil Depth [10"]
(SP-SC FILL) FINE TO MEDIUM SAND WITH CLAY, Brown to Red, Moist, Very Loose
(SP-SC) FINE TO MEDIUM SAND WITH CLAY, Red to Tan, Moist, Very Loose to Loose
(SC) CLAYEY SAND, Red to Tan, Moist, Loose
(SM) SILTY SAND, Brown to Tan, Moist to Wet, Loose
END OF BORING @ 25.0'

Sample No.	Sample Type	Sample Dist. (in)	Recovery (in)	Blows/6"	SPT (blows/ft)
S-1	SS	18	18	2 2 2	4
S-2	SS	18	18	1 2 1	3
S-3	SS	18	18	2 2 3	5
S-4	SS	18	18	3 4 6	10
S-5	SS	18	18	4 5 2	7
S-6	SS	18	18	1 2 3	5
S-7	SS	18	18	2 3 5	8

Depth (ft): 0, 5, 10, 15, 20, 25, 30

Elevation (ft): 200, 195, 190, 185, 180, 175



SODA CITY
ENGINEERING & CONSULTING

Soil Properties – Estimated from Boring Log B3

"Very Loose" SP-SC Material, Clayey-Sand

$Unit\ Weight\ \gamma = 115\ pcf$

$Angle\ of\ Friction\ \emptyset' = 30\ deg$

$Cohesion\ c' = 0\ psf$

$Standard\ Blow\ Count\ N_{60} = 4$

$Corrected\ Blow\ Count\ (N_1)_{60} = 6$

$Poisson's\ Ratio, \mu_s = 0.3$

$Modulus\ of\ Elasticity, E_s = 40{,}000\ psf$

$Atmospheric\ pressure, P_a = 2000\ psf$

$\propto = 5\ for\ sandy\ materials$

$Shear\ Modulus = 15{,}385\ psf$

$$(N_1)_{60} = CN * N_{60} = (1.64 * 4) = 6.51 = 6$$

$$CN = \left[\left(\frac{1}{115pcf * 6.5ft}\right)/(2000psf)\right]^{0.5} = 1.64$$

$$\emptyset' = \sqrt[2]{(20 * 6)} + 20 = 31 = 30\ deg$$

$$E_s = \propto * N_{60} * P_a = (5 * 4 * 2000) = 40{,}000\ psf$$

$$G_s = [(E_s)/(2 * (1 + \mu_s)] = \frac{40{,}000psf}{2(1 + 0.3)} = 15{,}385\ psf$$

Bearing Capacity Example Calculation – (A Columns)

$$Bearing\ Capacity\ q_u = \left(q * N_q * F_{qs} * F_{qd} * F_{qc}\right) + (0.5 * \gamma * B * N_\gamma * F_{\gamma s} * F_{\gamma d} * F_{\gamma c})$$

$$where\ q = surcharge = \gamma * D_f$$

$$\emptyset' = 30\ deg \rightarrow N_q = 18.4, N_\gamma = 22.4$$

$$Shape\ Factors$$

$$F_{qs} = 1 + (1ft * \tan(30)) = 1.57, F_{\gamma s} = 1 - (0.4 * 1ft) = 0.6$$

$$Depth\ Factors$$

$$F_{qd} = 1 + 2\tan(30)\,(1 - \sin(30))^2 \left(\frac{1}{\frac{5.5}{2}}\right) = 1.05\ , F_{\gamma d} = 1$$

$$Compressibility\ Factors$$

$$I_r = G_s/(q' * \tan(\emptyset') = 61.79\ < (I_r)_{cr} = 69.62\ \rightarrow Local\ Shear\ Failure\ Governs$$

$$F_{qc} = F_{\gamma c} = e^{\left[(-4.4+F_{\gamma s})\tan(\emptyset')+((\frac{3.07\sin(\emptyset')(\log(2*I_r))}{1+\sin(\emptyset')})\right]} = 0.95$$

$$q_u = 115\ psf * 18.4 * 1.57 * 1.05 * 0.95 + \left(\frac{1}{2}\right) * 115\ pcf * 5.5ft * 22.4 * 0.6 * 1 * 0.95$$
$$= 7351\ psf$$

$$Factor\ of\ Safety = 3$$

$$q_{allowable} = \frac{7351psf}{3} = 2450\ psf \cong 2500psf$$

Settlement Calculation

$$Settlement, S_e = q_0(\alpha * B')(\frac{1-\mu_s^2}{E_s}) * I_s I_f$$

$$= 2500\ psf\left(1 * \left(\frac{5.5}{2}\right)\right) * \left(\frac{1-0.3^2}{40{,}000}\right) * (0.59) * (0.9) = 0.08ft * \left(\frac{12in}{ft}\right) = 0.96\ in\ > 1\ in$$

Stormwater sewer drainage design formulas and calculations:

The Rational Method Formula

$$Q = CIAC_f$$

Where:	Q	=	discharge rates in cubic feet per second (cfs),
	C	=	runoff coefficient for the watershed,
	I	=	rainfall intensity (for duration equal to time of concentration) in inches per hour,
	A	=	area of watersheds contributing to the design location, in acres,

And C_f is a coefficient defined by:

Recurrence Interval (Years)	C_f
2-10	1.00
25	1.10
50	1.20
100	1.25

Weighted Runoff coefficient

$$C_W = \frac{\sum (C_i \times A_i)}{\sum A_i}$$

Where:	C_W	=	area weighted runoff coefficient,
	C_i	=	runoff coefficient for land cover *i*,
And	A_i	=	area of land cover *i*

Table 2
Recommended Runoff Coefficients

Land Cover Description		Range of Runoff Coefficients	Recommended Runoff Coefficient
Business, Industrial, and Commercial		0.80 to 0.90	0.85
Apartments		0.65 to 0.75	0.70
Schools		0.50 to 0.60	0.55
Residential:	10,000 $ft.^2$ lots	0.40 to 0.50	0.45
	12,000 $ft.^2$ lots	0.40 to 0.45	0.42
	17,000 $ft.^2$ lots	0.35 to 0.45	0.40
	lots ½ acre or more	0.30 to 0.40	0.35
Parks, cemeteries, and unimproved areas		0.20 to 0.35	0.30
Paved and Roof Areas		-	0.90
Cultivated Areas		0.50 to 0.70	0.60
Pasture		0.35 to 0.45	0.40
Forest		0.20 to 0.30	0.25
Lawns		0.20 to 0.40	0.30

SCS Upland Method time of concentration formula

Time of concentration should be determined using the SCS Upland Method[3]:

$$T_c = \sum T_i \text{ and } T_i = \frac{aL_i}{\sqrt{S_i}}$$

Where: T_C = time of concentration at the point under consideration (minutes),

T_i = overland flow time on surface i (minutes),

L_i = length of overland flow on surface i (feet),

S_i = average slopes of surface i (percent)

And a is a coefficient related to the surface characteristics as defined below:

Surface Characteristics[4]	*a*
Forest with heavy ground litter; hay meadow (overland flow)	0.0668
Trash fallow or minimum tillage cultivation; contour or strip cropped; woodland (overland flow)	0.0334
Short grass pasture (overland flow)	0.0238
Cultivated straight row crop (overland flow)	0.0185
Nearly bare and untilled (overland flow)	0.0167
Grassed waterway (shallow concentrated flow)	0.0111
Developed Conditions: Unpaved (shallow concentrated flow)	0.0103
Developed Conditions: Paved areas and shallow gutters (shallow concentrated flow)	0.0082

Rainfall Intensity equation, IDF curve coefficients

4.1.3.1 Rainfall Intensity (I): Rainfall intensity (I) is the average rainfall rate, in inches per hour, for duration equal to the time of concentration for a selected rainfall frequency. Rainfall intensities are to be computed using the following formula[2]:

$$i = \frac{a}{(b + t_c)^c}$$

Where: i = rainfall intensity in inches per hour,

t_c = time of concentration in minutes,

And a, b, and c are coefficients as presented below.

Recurrence Interval (years)	*a*	*b*	*c*
2	244.34492	34.95806	1.03155
5	258.50572	32.75684	1.01773
10	267.54247	31.39986	1.00904
25	279.77346	29.59043	0.99735
50	288.71309	28.26125	0.98879
100	296.66217	27.04859	0.98111

Rainfall intensities for times ranging from 5 minutes to 2 hours, for the 2-, 5-, 10-, 25-, 50-, and 100-year recurrence intervals are shown in Richland County Design Chart No. 1.

<u>Inlet runoff calculation spreadsheet sample</u>

Curb Inlet on Gervais Street

Runoff Coefficents and Acreage

Land Use	C value	Acres	Product	Weighted C value
Green Space	0.30	0.07	0.0210927	0.70
Pavement (Business, Commercial)	0.85	0.19	0.16429735	
Sum	---------------------------------->	0.2636	0.18539005	

Time of Concentration

Land Use	a, surface coefficient	L_i, length of flow (feet)	S_i, slope (percent)	T_i (minutes)	T_c (minutes)
Pavement	0.0082	17.58	0.056882821	0.60	2.64 < 5 minute minimum, so use 5 minute time of concentration
Green Space	0.0238	32.23	0.837728824	0.84	
Pavement	0.0082	36.54	2.162014231	0.20	
Pavement (Street Curb)	0.0082	109.14	0.815466373	0.99	

Rainfall Intensity

Reccurence Interval (years)	Intensity Coefficients a	b	c	T_c (minutes)	I, intensity (in/hr)
10	267.54247	31.39986	1.00904	5.00	7.12
25	279.77346	29.59043	0.99735		8.16
50	288.71309	28.26125	0.98879		9.03
100	296.66217	27.04859	0.98111		9.88

Discharge Rates

Recurrence Interval (years)	Richland County C_f	Q, discharge (cfs)
10	1.00	1.32
25	1.10	1.66
50	1.20	2.01
100	1.25	2.29

Equations
$T_i = (aL_i)/(\text{sqrt}(S_i))$
$T_c = \Sigma(T_i)$
$I = a/(b+T_c)^c$
$Q = CIAC_f$

Pavement Design Table for Structural Number

S.C. Department of Highways and Public Transportation
Coefficients of Relative Strength for
Flexible Pavement Components

July, 2008

Pavement Component

Surface Course	a_1
HMA Surface	0.44[1]
HMA Intermediate	0.44[1]
Open Graded Friction Course	0.44[1]
Bituminous Surfacing	0.35

Old Surface	
Old Asphalt Concrete Surface	0.26
Old Asphalt Concrete Binder	0.26
Old Sand Asphalt	0.16
Bituminous Surfacing	0.21

Base	a_2
Sand-Clay Base	0.12-0.20[2]
Coquina Shell Base	0.12
Graded Aggregate Base	0.18
Cement Stabilized Earth Base	0.25
Asphalt Base, Type D	0.25[2]
Asphalt Base, Type A, B and C	0.34
Cement Modified Recycled Base	0.26
Cement Stabilized Aggregate Base	0.34
Old PCC Pavement	0.40

Subbase	a_3
Soil Aggregate Subbase	0.10
Cement-Modified Subbase	0.15[2]

Note 1. If the combined new HMA Surface and HMA Intermediate course rate exceeds 400 pounds per square yard, then coefficient of the excess material over 400 psy is reduced to 0.34. OGFC is not included in this total.

Note 2. Coefficient dependent on the quality of material available.

Figure 3 - Layer coefficients for South Carolina material

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Water and Sanitary Sewer Reference Tables

TABLE E103.3(2)
LOAD VALUES ASSIGNED TO FIXTURES[a]

FIXTURE	OCCUPANCY	TYPE OF SUPPLY CONTROL	LOAD VALUES, IN WATER SUPPLY FIXTURE UNITS (wsfu)		
			Cold	Hot	Total
Bathroom group	Private	Flush tank	2.7	1.5	3.6
Bathroom group	Private	Flush valve	6.0	3.0	8.0
Bathtub	Private	Faucet	1.0	1.0	1.4
Bathtub	Public	Faucet	3.0	3.0	4.0
Bidet	Private	Faucet	1.5	1.5	2.0
Combination fixture	Private	Faucet	2.25	2.25	3.0
Dishwashing machine	Private	Automatic	—	1.4	1.4
Drinking fountain	Offices, etc.	$^3/_8$″ valve	0.25	—	0.25
Kitchen sink	Private	Faucet	1.0	1.0	1.4
Kitchen sink	Hotel, restaurant	Faucet	3.0	3.0	4.0
Laundry trays (1 to 3)	Private	Faucet	1.0	1.0	1.4
Lavatory	Private	Faucet	0.5	0.5	0.7
Lavatory	Public	Faucet	1.5	1.5	2.0
Service sink	Offices, etc.	Faucet	2.25	2.25	3.0
Shower head	Public	Mixing valve	3.0	3.0	4.0
Shower head	Private	Mixing valve	1.0	1.0	1.4
Urinal	Public	1″ flush valve	10.0	—	10.0
Urinal	Public	$^3/_4$″ flush valve	5.0	—	5.0
Urinal	Public	Flush tank	3.0	—	3.0
Washing machine (8 lb)	Private	Automatic	1.0	1.0	1.4
Washing machine (8 lb)	Public	Automatic	2.25	2.25	3.0
Washing machine (15 lb)	Public	Automatic	3.0	3.0	4.0
Water closet	Private	Flush valve	6.0	—	6.0
Water closet	Private	Flush tank	2.2	—	2.2
Water closet	Public	Flush valve	10.0	—	10.0
Water closet	Public	Flush tank	5.0	—	5.0
Water closet	Public or private	Flushometer tank	2.0	—	2.0

For SI: 1 inch = 25.4 mm, 1 pound = 0.454 kg.

a. For fixtures not listed , loads should be assumed by comparing the fixture to one listed using water in similar quantities and at similar rates. The assigned loads for fixtures with both hot and cold water supplies are given for separate hot and cold water loads and for total load. The separate hot and cold water loads being three-fourths of the total load for the fixture in each case.

TABLE E103.3(3)
TABLE FOR ESTIMATING DEMAND

SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH TANKS			SUPPLY SYSTEMS PREDOMINANTLY FOR FLUSH VALVES		
Load	Demand		Load	Demand	
(Water supply fixture units)	(Gallons per minute)	(Cubic feet per minute)	(Water supply fixture units)	(Gallons per minute)	(Cubic feet per minute)
1	3.0	0.04104	—	—	—
2	5.0	0.0684	—	—	—
3	6.5	0.86892	—	—	—
4	8.0	1.06944	—	—	—
5	9.4	1.256592	5	15.0	2.0052
6	10.7	1.430376	6	17.4	2.326032
7	11.8	1.577424	7	19.8	2.646364
8	12.8	1.711104	8	22.2	2.967696
9	13.7	1.831416	9	24.6	3.288528
10	14.6	1.951728	10	27.0	3.60936
11	15.4	2.058672	11	27.8	3.716304
12	16.0	2.13888	12	28.6	3.823248
13	16.5	2.20572	13	29.4	3.930192
14	17.0	2.27256	14	30.2	4.037136
15	17.5	2.3394	15	31.0	4.14408
16	18.0	2.90624	16	31.8	4.241024
17	18.4	2.459712	17	32.6	4.357968
18	18.8	2.513184	18	33.4	4.464912
19	19.2	2.566656	19	34.2	4.571856
20	19.6	2.620128	20	35.0	4.6788
25	21.5	2.87412	25	38.0	5.07984
30	23.3	3.114744	30	42.0	5.61356
35	24.9	3.328632	35	44.0	5.88192
40	26.3	3.515784	40	46.0	6.14928
45	27.7	3.702936	45	48.0	6.41664
50	29.1	3.890088	50	50.0	6.684
60	32.0	4.27776	60	54.0	7.21872
70	35.0	4.6788	70	58.0	7.75344
80	38.0	5.07984	80	61.2	8.181216
90	41.0	5.48088	90	64.3	8.595624
100	43.5	5.81508	100	67.5	9.0234
120	48.0	6.41664	120	73.0	9.75864
140	52.5	7.0182	140	77.0	10.29336
160	57.0	7.61976	160	81.0	10.82808
180	61.0	8.15448	180	85.5	11.42964
200	65.0	8.6892	200	90.0	12.0312
225	70.0	9.3576	225	95.5	12.76644
250	75.0	10.026	250	101.0	13.50168

(continued)

N.	Dentist Office: 1. Per Employee 2. Per Chair 3. Per Suction Unit; Standard Unit 4. Per Suction Unit; Recycling Unit 5. Per Suction Unit; Air Generated Unit	 15 8 370 95 0
O.	Factories, Industries: 1. Per Employee 2. Per Employee, with Showers 3. Per Employee, with Kitchen 4. Per Employee, with Showers and Kitchen	 25 35 40 45
P.	Fairgrounds: (Average Attendance, Per Person)	5
Q.	Grocery Stores: (Per one thousand (1,000) Square Feet, No Restaurant)	200
R.	Hospitals: 1. Per Resident Staff 2. Per Bed	 100 200
S.	Hotels: (Per Bedroom, No Restaurant)	100
T.	Institutions: (Per Resident)	100
U.	Laundries: (Self Service, Per Machine)	400
V.	Marinas: (Per Slip)	30
W.	Mobile Homes: (Per Unit)	300
X.	Motels: (Per Unit, No Restaurant)	100
Y.	Nursing Homes: 1. Per Bed 2. Per Bed, with Laundry	 100 150
Z.	Offices, Small Stores, Business, Administration Buildings: (Per Person, No Restaurant)	25
AA.	Picnic Parks: (Average Attendance, Per Person)	10
BB.	Prison/Jail: 1. Per Employee 2. Per Inmate	 15 125
CC.	Residences: (Per House, Unit)	400
DD.	Rest Areas, Welcome Centers: 1. Per Person 2. Per Person, with Showers	 5 10

Reference Boring Logs for Pavement Design

BORING LOG NO. SB-1

PROJECT: USC Incubator Building

CLIENT: Bradley and Associates, LLC
Columbia, SC

SITE: 707 Catawba Street
Columbia, SC

LOCATION See Exhibit A-2

Latitude: 33.9871° Longitude: -81.036°

Approximate Surface Elev: 179 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.2	**ASPHALT CONCRETE**, (2 inches Asphalt)	179+/-							
3.0	**FILL - SILTY SAND (SM)**, with rock fragments and brick fragments, fine to medium grained, brown, loose	176+/-			X	2-3-3 N=6			
5.0	**CLAYEY SAND (SC)**, fine to medium grained, mottled (brown, orange, tan), medium dense	174+/-	5		X	4-5-5 N=10			

Boring Terminated at 5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
2-1/4" Hollow Stem Auger

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS
No free water observed at end of drilling

Terracon
521 Clemson Rd
Columbia, SC

Boring Started: 4/1/2016	Boring Completed: 4/1/2016
Drill Rig: CME-550X	Driller: A. Large
Project No.: 73165024	Exhibit: A-8

BORING LOG NO. SB-2

PROJECT: USC Incubator Building

CLIENT: Bradley and Associates, LLC
Columbia, SC

SITE: 707 Catawba Street
Columbia, SC

LOCATION See Exhibit A-2

Latitude: 33.987° Longitude: -81.0359°

Approximate Surface Elev: 178 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.2	**ASPHALT CONCRETE**, (2-1/2 inches of asphalt)	178+/-							
2.0	**Concrete**, (21-1/2 inches of concrete/stone base)	176+/-			X	4-3-3 N=6			
3.0	**FILL - CLAYEY SAND (SC)**, with crushed aggregate, fine to medium grained, brown, loose	175+/-							
5.0	**CLAYEY SAND (SC)**, fine to medium grained, mottled (brown, orange, tan), medium dense	173+/-	5		X	8-9-10 N=19			
	Boring Terminated at 5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
2-1/4" Hollow Stem Auger

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed at end of drilling

Terracon
521 Clemson Rd
Columbia, SC

Boring Started: 4/1/2016	Boring Completed: 4/1/2016
Drill Rig: CME-550X	Driller: A. Large
Project No.: 73165024	Exhibit: A-9

BORING LOG NO. SB-3

PROJECT: USC Incubator Building

CLIENT: Bradley and Associates, LLC
Columbia, SC

SITE: 707 Catawba Street
Columbia, SC

LOCATION See Exhibit A-2

Latitude: 33.9869° Longitude: -81.0359°

Approximate Surface Elev: 177 (Ft.) +/-

GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.2	**ASPHALT CONCRETE**, (2 inches Asphalt)	177+/-							
	3.0	**SILTY SAND (SM)**, fine to medium grained, brown, loose	174+/-			X	4-4-4 N=8	7	NP	16
	5.0	**CLAYEY SAND (SC)**, fine to medium grained, mottled (brown, orange, tan), loose	172+/-	5		X	3-4-5 N=9			
		Boring Terminated at 5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
2-1/4" Hollow Stem Auger

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS
No free water observed at end of drilling

Terracon
521 Clemson Rd
Columbia, SC

Boring Started: 4/1/2016	Boring Completed: 4/1/2016
Drill Rig: CME-550X	Driller: A. Large
Project No.: 73165024	Exhibit: A-10

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